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Vol. 31, Part 3. SEPTEMBER, 1960.

THE

TEA QUARTERLY

THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St Coombs, Talawakele,
Ceylon.

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Publications.—The Tea Quarterly, Bulletins (New Series), Pamphlets, and Annual Reports, published by the Tea Research Institute will be sent free of charge to Superintendents of Ceylon tea estates over ten acres in extent and to estate agencies dealing with Ceylon tea, if they register their names with the Director, Tea Research Institute of Ceylon, St Coombs, Talawakele.

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THE TEA QUARTERLY

Vol. 31 September, 1960 Part 3

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EDITORIAL COMMENT

Plant Nutrition

Mr Tolhurst's article gives, for the attention of planters, a timely explanation of some of the complexities of plant nutrition, and explains why "we are so rarely able to give a direct answer to an apparently simple question". The problems of experimentation in the field of plant nutrition are very considerable, and it may be noted that we have to plan to provide the proper facilities for trials on clonal tea many years ahead. Information provided by soil analyses is of limited value, for no methods of chemical extraction imitate sufficiently exactly the extraction methods used by the plant.

Organic matter

It is perhaps true that most of us tend to think of the return of organic matter to the soil more in terms of loppings, compost or manure than in terms of the considerable amount returned by the foliage and prunings of tea bushes. Dr Visser's article serves to stress the latter, and gives rough indications of the effect of the type of plucking practice on the amount returned.

Work on various aspects of the subject of soil organic matter is going forward. Dr Mulder's article on *Poria* introduces indirectly a discussion on the way in which soil organic matter can affect the occurrence of a disease. There may well be a relation between the amount of soil organic matter and the occurrence of several other diseases and pests, but with regard to tea this is not yet proven. This is a field of work requiring detailed research and long-term investigation. In other countries, the results obtained so far have seldom been clear cut; nevertheless there is a growing body of evidence which points to the effect of inadequate soil organic matter, and also of the balance of nutrients, on the occurrence of many diseases and pests.

Replanting

Mr Elias was asked to write an article giving his views on the errors made in the No. 1 Field clearings at St Coombs. In his article, he has covered a wide range of matters that need attention when replanting, and has given an account of the lessons to be learned from earlier experience at St Coombs.

Eelworms

Dr Hutchinson's article refers to the decision by the Board that we can best serve the Industry by concentrating upon research and that routine soil samples for eelworm analysis from estates will in future be referred to the three commercial companies who have generously offered to accept them. In connection with this, he has clarified the position as to when and how sampling should be done, and has added a note on the fumigation of nurseries which, as he stresses, should be done as a routine before planting.

Letter to the Editor

Mr R. K. Christie, in his letter on green manure and shade trees, has raised a most important subject, and, quite clearly, many aspects of the use of shade trees

are confused and controversial. The Institute has carried out, and is continuing with, experiments on some aspects of shade; but we should be glad to hear from other planters who may have strong views on this subject.

Biennial Conference 1960

In the past, the tradition of a biennial conference of the Institute, with set papers on a variety of topics followed by discussion, was kept up until 1955. Since then, two symposia, in 1956 and 1958, have been held.

It has now been decided to hold a general conference on a variety of topics on the 20th and 21st January 1961, in Colombo. This will be the 12th Biennial Conference. Papers will deal with both finished work and work in progress. It is hoped that many people will be able to attend.

COMPLEXITIES IN PLANT NUTRITION AND THEIR RELATION TO MANURING PRACTICE

J. A. H. Tolhurst

In a recent article (Tolhurst, 1959) dealing with the more obviously practical aspects of manuring, I mentioned that the problems there encountered could often be increased by the inevitable splitting-up of the manurial chemicals into highly reactive component parts. The reactions which occur between the manure and the soil are of great practical importance, but in the present note I wish to emphasise the parallel group of reactions between the manurial components and the plant, hoping thereby to promote a better understanding of some of the reports on manurial experiments which have been and will be issued (Tolhurst, 1960). Unless there is an appreciation of the basic priciples involved in plant nutrition, here referring to the uptake of plant food from the soil, it is highly probable that successive reports will give the impression of undue fickleness.

Plant roots are not merely syphon tubes but are very active organs which have to work in order to extract most of the required plant food. To do this they must themselves be fed, relying on the manufacture of carbohydrates in the leaves to provide fuel. To a certain extent, roots are selective in their uptake of nutrients, but this feature is easily upset, sometimes because there is an unusually large amount of one plant food in the neighbourhood of the roots.

It is well known in physiological research that a delicate balance may have to be kept between certain nutrients, if both are to be taken up by a plant in adequate amounts. Two plant foods which show a strong *antagonism* are calcium and potassium. If the proportion of calcium in the soil is increased too greatly, then potassium deficiency will occur inside the plant, even though the external supply of potassium to the roots would have been sufficient had there been less calcium. Similarly, an undue increase in potassium will lower the efficiency of uptake of calcium. In this instance, the ratio between the two plant foods is of paramount importance, while the actual level of each nutrient is of much less importance. Instances are known where plants may be able to absorb sufficient magnesium from a particular soil if nitrogen is applied in the nitrate form, but may suffer from magnesium deficiency if ammonium is used as the source of nitrogen. This appears to be a direct effect of the latter form of nitrogen and the examination of magnesium deficiency symptoms arising in this way would involve more than a simple analysis of magnesium levels.

Not all nutrients display antagonistic tendencies and instances are known where the presence of one plant food may increase the uptake of another nutrient; for example, ammonium nitrogen favours the uptake of phosphate by many plants. This is true *synergism*, but an impression of synergism may arise in a devious way. Suppose that nutrient x depresses the uptake of nutrient y and vice versa (antagonism). A third nutrient, z, may then be introduced into the region of the plant roots which also depresses the uptake of y, thereby allowing a freer passage to x. The final picture could thus be that nutrient z assists (synergises) the uptake of nutrient x. We have reason to believe that something of this nature has actually occurred on one of our long-term manurial trials, involving boron, calcium and potassium as nutrients x, y and z, respectively (Tolhurst, 1960.)

Even when plant foods have passed such obstacles and have been transported into the foliage of a plant, in apparently sufficient quantity, it may still be found that

symptoms of malnutrition may occur. Iron, an essential nutrient for plants, is notoriously subject to interference within the plant. Several elements, some themselves essential plant foods, if present in the plant tissues in too great proportions, may transform iron into a form which is largely useless to the life cycle within the cells. It has often been observed that iron-deficient leaves, obviously suffering severely, have more iron than corresponding healthy leaves. Manganese, again an essential plant food, is perhaps the chief culprit, and we have evidence that an excessive uptake of manganese by tea is not uncommon, giving rise to a chlorosis of the leaves which can be partially cured by iron-containing sprays. The reason for the accumulation of manganese in the bush is probably linked with the use of sulphate of ammonia as a manure. We do not suspect, however, a synergism of nutrient uptake, whether direct or indirect, but rather a straightforward chemical reaction between the soil reserves of manganese and the manure. It may further be of interest to note that some species of plants have been known to take up more manganese when grown under conditions of higher intensity of light, thus introducing yet another complicating factor, and one which has to be borne in mind when assessing the value of soil analyses for manganese. It is also known that many plants, and perhaps all, require higher levels of potassium in the foliage if they are to remain free from deficiency symptoms when grown under high intensities of light. Here, the interpretation of chemical analysis of the leaf would need to take such factors into account, and we have already begun to use more than one standard of interpretation for potash deficiency in tea, according to the climatic zone.

On the face of it, such studies have a nightmarish quality, and it may be seen why in this subject we are so rarely able to give a direct answer to an apparently simple question. It may also be seen why field trials of considerable complexity are necessary, with repetition under different conditions. We not only have to determine the optimum *level* of each plant food to be applied as manure, but also the safest *ratios* between two or more nutrients and, as these two considerations may affect each other, we would need to experiment with varying combinations of the chosen treatments. We would have as many different *levels* as we wished, and we would have to consider five major manurial nutrients, nitrogen, phosphorus, potassium, calcium, magnesium, even if we were to omit actual treatments with the micro-nutrients, *viz.* manganese, iron, boron, etc. If we were to design an experiment with all possible combinations of five nutrients each at three levels we should have 243 different plots, even without replication. It would still be necessary to repeat this pattern to test the influence of different soil types and climatic conditions, which can, as has been hinted above, play their own part in deciding the efficiency of manurial levels and ratios. Now suppose that various methods of distribution and timing of the manure mixtures were to be tested as well, and possibly different methods of cultivation. The number of combinations would reach four figures for each experimental site, and to avoid this we resort to statistical techniques whereby smaller experiments can be designed to test some of the many possible combinations. Such mathematical designs also enable us to decide to what extent a difference in, say, yield between two treatments is likely to have been due to the treatments themselves or to some unknown factor, or to the large number of factors that we call chance. In other words, we aim to estimate the odds for and against a certain result occurring if a certain treatment were to be repeated elsewhere, or were to be recommended for practical adoption by estates.

Yield records provide an excellent and eminently practical way of finding out how the bush has reacted to various treatments. They are not so helpful in deciding why such responses have occurred, and still less helpful in predicting what may happen in the future. Therefore chemical analysis, both of the soil and of the bush, has to be brought into the picture, but bearing in mind that caution is required in the application and interpretation of such analysis. There are many and varied methods, for example, for the extraction of nutrients from the soil but it is not possible *a priori* to use the results of any one of these methods in predicting the ability

of a soil to supply nutrients to the tea bush, until we have actually assessed the reaction of the bush itself to that particular soil. Several examples quoted in these notes will have shown how complex the interaction between bush, climate, and soil can be, and may serve to show why we place so much stress on the necessity for well planned field trials, under varied conditions, run in conjunction with chemical investigations.

References

TOLHURST, J. A. H. (1959.)—General principles of soil cultivation and of methods of manure application to tea. *Tea Quart* **30:** 19–29.

TOLHURST, J. A. H. (1960.)—Report of the Agricultural Chemist. *Annu. Rep. Tea Res. Inst. Ceylon for* 1959.

ESTIMATIONS OF ORGANIC MATTER SUPPLIED BY REGULARLY PLUCKED TEA BUSHES

T. Visser

1. Introduction

It is common knowledge that the addition of organic material in the form of loppings, compost or manure helps to maintain and increase the fertility of the soil. However, it is not so often realised that the tea bush itself returns a considerable amount of organic matter which contributes to humus and nutrient conservation.

In the first place, pruning periodically returns sizeable amounts of material; Eden (1937), who determined the dry weight of foliage from prunings on six estates at different altitudes, found that the amount varied between 0.7 and 1.4 tons per acre.

Secondly, poor light conditions under the plucking table cause a continual and substantial leaf-fall throughout the cycle, but little information is available on this subject. It was thought useful, therefore, to estimate, from available data for different plucking methods, the contribution made by both prunings and fallen leaves towards the organic matter supply of a tea field.

2. Leaf abscission in relation to time after pruning

Figures obtained by Tubbs (1935) of the dry weights of flush harvested over nine successive periods of 63 days from tipping, and of the dry weights of maintenance foliage determined at the end of each period, give an indication of when leaf abscission commences. Since the flush was plucked to the single leaf, it is possible to calculate from the weight of flush (F) harvested in each period of 63 days, and from the average dry weight of a flush shoot (FW) [on the average 0.11 g. in the 1st and 0.09 g. in the 2nd year after pruning, according to Tubbs (1937)], how many single leaves would be added per period (F/FW). Likewise, from the total weight of the maintenance foliage (M) present at each time, and the average dry weight per leaf (MW) [on the average 0.175 g. according to Visser (1958)], the number of maintenance leaves actually present can be assessed (M/MW). The calculated data are given in Table 1.

TABLE 1.—*Calculated numbers of leaves present, and assessed numbers, on regularly-plucked tea bushes in relation to time after tipping (calculations from weights of flush and of foliage determined by Tubbs*, 1935)

1	2	3	4
Days after tipping	Single leaves added per period	Single leaves present	
		Calculated*	Assessed
63	—	(500)	500
126	220	720	940
189	270	990	1310
252	270	1260	1160
315	310	1570	1490
378	400	1970	1960
441	410	2380	2290
504	320	2700	2280
567	420	3120	2540

*Column 3 shows the cumulative totals of Column 2, plus the initial 500 leaves.

It will be seen from Table 1, that the actual number of leaves present on the bush (Column 4) is initially greater—until after about six months from tipping—than was expected from calculation (Column 3). At this stage, probably, not all pluckable shoots were removed, as a regular plucking table had still to be formed. From between 378 and 441 days after tipping, the expected number exceeds the number of leaves actually present, indicating that leaf abscission became a substantial feature from that time, amounting to about 400 leaves in 63 days, rising to nearly 600 in the next 63 days.

If this leaf-drop had been maintained over a three-year pruning cycle (32 months plucking) each bush would have dropped 3,000 leaves which, on the basis of 3,000 bushes per acre and a leaf weight of 0.175 g. would be equivalent to 1.55 tons of dry organic matter per acre.

3. Organic matter supplied as foliage in a three and four-year pruning cycle up-country

The calculations below are based on the results of the 6th cycle of the old and the 1st cycle of the new fish-leaf plucking experiment carried out at St Coombs (Visser, 1960, 1960a).

3.1. Single-leaf plucking, 3-year cycle

Bushes, continuously single-leaf plucked, carried at the time of clean pruning 1.21 tons of foliage which, on the basis of 3,000 bushes per acre, works out at 410 g. dry weight, or 2,340 leaves (410/0.175) per bush.

According to figures given by Tubbs (1935) (see Table 1, Column 4), bushes that are plucked regularly carry the equivalent of 1490 leaves ten months after tipping.

In 110 rounds, the bushes produced 3,495 lb. made tea per acre which amounts to 19.2 g. fresh weight per bush per pluck. The average fresh weight per pluckable shoot was found to be 0.52 g. (Visser, 1960); thus, on the average 37 shoots were removed per round. Since each shoot was plucked to the single leaf, it means that, in the 80 rounds of the last two years, $80 \times 37 = 2,960$ leaves were added per bush.

As the number of maintenance leaves present ten months from tipping was assumed to be 1,490, the calculated total number of leaves formed by the time of pruning would have amounted to 2,960 + 1,490=4,450 leaves. However, in fact, only 2,340 leaves were present, so that 4,450–2,340=2,110 leaves per bush must have dropped. This amounts to 1.09 tons dry organic matter per acre, to which must be added 0.35 tons from tippings and 1.21 tons foliage from prunings; hence the bushes yielded in total 2.65 tons dry organic matter per acre as foliage in a 3-year cycle.

3.2. Perennial fish-leaf plucking, 3-year cycle

The foliage from continuously fish-leaf-plucked bushes remains, on account of the plucking system and the low abscission rate, more or less static (Eden, 1947; Visser, 1960). However, a certain number of leaves are likely to be added as, now and then, leaves form in or under the plucking table, whilst shoots are sometimes passed over in plucking. Some of the foliage drops in the course of the cycle, which might perhaps be of the order of one-fifth of that of single-leaf-plucked bushes, or 0.22 tons per acre. Also, 0.14 tons were returned in the form of tippings and 0.44 tons as foliage from prunings, and thus bushes plucked to the fish leaf provided 0.80 tons of dry organic matter per acre as foliage in three years, which is 70% less than was produced by single-leaf-plucked bushes.

3.3. Single-leaf plucking, 4-year cycle

The calculations in this instance were basically the same as those in paragraph 3.1, with respect to single-leaf plucking over a 3-year cycle, so that the result only is given here.

Leaves dropped were calculated to amount to 1.23 tons per acre, to which must be added 0.26 tons of tippings and 1.80 tons of foliage from prunings. Accordingly, single-leaf-plucked bushes are estimated to have supplied 3.29 tons of dry organic matter per acre as foliage in a 4-year cycle.

3.4. Limited fish-leaf plucking, 4-year cycle

In the field trial where fish-leaf plucking was preceeded by ten months of normal plucking and succeeded by ten months of resting before pruning, it was found that the bushes carried at the end of the cycle 2.25 tons of foliage (25% more than single-leaf-plucked bushes, due to resting). During both the first period of normal plucking and also the succeeding period of fish-leaf plucking, the number of leaves dropped is likely to have been small. During the resting period, relatively more leaves may have dropped.

The total amount is estimated to have been one-fifth of that of single-leaf plucked bushes, or 0.25 tons. Inclusive of 0.25 tons of tippings, bushes plucked to the fish-leaf for part of a 4-year cycle produced 2.75 tons dry organic matter as foliage, which is 13% less than supplied by single-leaf-plucked bushes.

4. Organic matter supplied as foliage in a one-and-a-half year pruning cycle in the low-country

The data of a trial on Endane Estate near Ratnapura (Visser, 1960, 1960a) were taken as a basis for calculation.

4.1. Single-leaf plucking

At the time of pruning 0.61 tons of foliage per acre were supplied from prunings, which, assuming that a maintenance leaf weighs 0.2 g., is equivalent to 1,035 leaves per bush. As the yield over 67 rounds was 2,265 lb. of made tea, it can be calculated—on the assumption that the fresh weight of a pluckable shoot is 0.55 g. —that 2,280 new leaves were added per bush during the plucking stage, whilst it is estimated that 200 leaves were added before tipping. Accordingly, 2,280+200 —1,035=1,445 leaves per bush dropped, which is equivalent to 0.85 tons organic matter per acre. In reality, at the end of the cycle the bushes carried more foliage than is shown by the figure determined from prunings, because they were rim-lung pruned at a height of 22″—24″. This amount is estimated to have been one-third of that removed; it can be assumed, however, that this old foliage (0.20 tons) drops in the course of the cycle.

Therefore, inclusive of tippings (0.08 tons), the organic matter which became available as foliage amounted in total to 0.61 + 0.85 + 0.20 + 0.08=1.74 tons per acre in a 1½-year cycle.

4.2. Limited fish-leaf plucking

Bushes fish-leaf-plucked for the later half of the cycle carried 10% less foliage than normally plucked bushes at the time of pruning; the foliage amounted to 0.55 tons per acre or 930 leaves per bush. During the period of 28 plucks that the bushes were plucked to the single leaf, they yielded 950 lb. made tea, which equals 21.2 g. fresh weight, or 35 pluckable shoots, per bush per round. Accordingly, in addition to the estimated number of 200 leaves formed before tipping, another 28 × 35=980 leaves were formed during the first half of the cycle. Again, on the assumption that the number of leaves left amounted to one-third of the number

removed at pruning, and that these (310) subsequently drop, the total number of leaves dropped would amount to 980 + 200 + 310 — 930=560 leaves per bush or 0.34 tons per acre.

Including tippings (0.09 tons), bushes fish-leaf-plucked for half of a 1½-year cycle yielded 0.55 + 0.34 + 0.09=0.98 tons dry organic matter, which is 44% less than supplied by normally plucked bushes.

5. Summary and conclusions

The amount of dry organic matter in foliage returned to the soil from tea bushes varies with different plucking methods and with pruning cycles of different lengths. Data on natural leaf-fall were obtained by calculation and estimation; the other data on the foliage returned from tippings and prunings were obtained by direct weighing.

The results are summarised in Table 2, which also gives the amounts of made tea and of wood from prunings, determined as averages per year for the pruning cycles of different lengths.

TABLE 2.—*Estimated dry organic matter in terms of foliage and wood supplied by single-leaf and fish-leaf-plucked bushes expressed in tons per acre per year*

Treatment	Foliage	Made tea	Wood	Total
Low-country, 1½-year cycle				
Continuous single-leaf ...	1.16	0.67	0.81	2.64
Single-leaf/fish-leaf ...	0.65	0.77	0.74	2.16
Up-country, 3-year cycle				
Continuous single-leaf ...	0.88	0.52	1.05	2.45
Continuous fish-leaf ...	0.27	0.56	0.25	1.08
Up-country, 4-year cycle				
Continuous single-leaf ...	0.82	0.49	1.31	2.62
Single-leaf/fish-leaf ...	0.69	0.64	0.91	2.24

It will be seen from Table 2 that the top part of normally plucked bushes can supply approximately 2.5 tons of dry organic matter per acre per annum in total, of which about 2 tons are returned to the soil both in the low-country and in the up-country. The table also shows that about one-third of the organic matter of the foliage, and about one-quarter to one-fifth of the total organic matter (including wood) produced by single-leaf-plucked bushes is removed to produce made tea.

It appears further from Table 2 that limited fish-leaf plucking causes a loss of less than 20% of the total amount of organic matter produced by single-leaf-plucked bushes, which can be considered tolerable. Continuous fish-leaf plucking leads in the long run to a marked, and no doubt harmful, reduction in the supply of organic matter, amounting after the 6th cycle of fish-leaf plucking to 56% in comparison with the control.

The weight of foliage removed at the time of pruning was 50% higher in our case (in 1958) than was found by Eden (in 1936), *i.e.* 1.2 tons as against 0.8 tons. Probably, improved management and manuring over the past 20 years were responsible for this increase, as is indicated by the fact that the yield of the field sampled by us was about 40% higher than that of the field at St Coombs assessed by Eden.

On an estate near Ratnapura, we determined that the bushes carried 0.9 tons of foliage at the time of pruning; Eden found 1.4 tons of foliage on an estate in the same district, but in his case the bushes were rested prior to pruning which could account for the difference.

On average, it appears that the amount of organic matter removed for producing made tea is about one-quarter of the total produced by the foliage and wood of the tea bush.

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PLANTING ON PORIA-INFECTED AREAS

D. Mulder

No one knows exactly how long a fungus in one form or another can stay alive in soil, but it is known that resting bodies (sclerotia) of certain fungi can survive for many years. This is most probably also true for the mycelium threads of *Poria hypolateritia* on woody roots. Therefore, replanting on old *Poria* patches carries a considerable risk of recurrence of the disease.

Poria disease originates from stumps of jungle trees; the stumps of Dun trees (*Doona gardneri*) are said to be especially dangerous. It is possible that this tree got a bad name because of the hardness and persistence of its stumps rather than because of any specific relation to *Poria*. In any case, it is a fact that many *Poria* areas are notable for the large number of jungle stumps in them. After the disappearance of the jungle stumps, the *Poria* survives in tea roots and shade tree stumps (especially *Albizzia moluccana* and Dadap).

How can re-infection of young tea with *Poria* be prevented? The clearing of infected material from the soil is only partially effective. No one will pretend that, after removing all roots of more than pencil thickness down to a level of 3–4 feet, all infected material has gone. *Poria* areas should, therefore, if possible, be kept longer under Guatemala grass than is normal for areas to be replanted, in order to starve the remaining *Poria* mycelium to death. If only parts of the area being replanted are affected, these could be marked off by planting the borders of the *Poria* areas with *Tephrosia*. This would at least indicate whether any *Poria*-infected material has been left in the soil along the border, for *Tephrosia* then soon wilts and dies.

We have no indication that any tea bush or clone is more resistant to *Poria* than another. When certain bushes survive for a time in a *Poria* patch, this may be due to better soil conditions locally, so that these bushes can develop new roots and survive longer. Another reason for a delay in the ultimate death of a bush might be that locally the water supply is better, which would reduce the wilting of the bush that is caused by *Poria* attack.

A special measure that could be taken before replanting a *Poria* area, in order to reduce the risk of recurrence of the disease, is the improvement of soil conditions, especially in organic matter content. The mixing of the top soil with a fairly big quantity of cattle dung or compost in the infected area would stimulate the growth of saprophytic fungi, which live on the compost, and reduce the chance of *Poria* reaching the tea roots (Sanford 1946). The interference of saprophytic fungi with the growth of *Poria* is under investigation at the moment and it has already been shown in the laboratory that a common soil fungus like *Trichoderma viride* strongly inhibits the growth of *Poria* (see Figures 1 & 2) (Allen & Haenseler 1935). Increasing the organic matter in the soil would stimulate the growth of this fungus.

Fig.1.— Growth of *Poria hypolateritia* in clay soil. Both tubes have been inoculated with *Poria*. The tube on the left contains soil which has been inoculated with a dilute suspension of *Trichoderma viride*; the tube on the right also contains clay soil without *Trichoderma*. Only in the tube on the right is the growth of the mycelium of *Poria* conspicuous.

Fig. 2.— Antagonism of *Trichoderma viride* to *Poria hypolateritia*, growing on potato-dextrose agar jelly. The Agar was inoculated with the *Poria* fungus (*left side*) five days before inoculation of *Trichoderma* (*right side*).

Trichoderma viride is a soil fungus which does not attack living plants but lives on dead organic material (*i.e.* a saprophyte, not a parasite). It frequently appears on the surface of steam-sterilised soil and has a high resistance to chemical soil disinfectants. It occurs in soils in almost all climates. Its ability to kill parasitic (and other) soil fungi by its secretion products is a very remarkable feature and is only over-shadowed by its ability actively to parasitize other soil fungi, such as the fungus called *Rhizoctonia*, which is the cause of a damping-off disease of seedlings (Weindling 1934). The effects of this fungus (*Trichoderma*) on parasitic root fungi have been studied in detail for *Armillaria* root rot of Citrus trees (Bliss 1951) and *Fomes annosus* root rot of pine trees (Rishbeth 1950, 1951, 1951a).

Ceylon tea soils are very suitable for the growth of this fungus in that it requires an acid soil. We have only to supply the necessary food in the form of organic material for its abundant growth. Its rapid growth in sterilized soil is due to the fact that the process of sterilization makes much more food available. In this connection the effect of partial soil sterilization by soil disinfectants (formalin, carbon disulphide, mercury compounds, etc.) and by soil fumigants has to be considered (Garrett 1957). It has been found that *Trichoderma* has a markedly higher resistance to various soil disinfectants than have parasitic soil fungi and therefore it survives the treatment. Garrett (1956) writes in his book "Biology of root-infecting fungi" that *Trichoderma* has been reported as the dominant fungus in soils after treatment with chloropicrin, D-D, and carbon disulphide.

Treatment of the soil with D-D against eelworms would therefore most probably have an indirect effect on *Poria* through the increase in population of *Trichoderma viride*. Unfortunately D-D cannot be used around existing tea plants because of its phytotoxicity. Nemagon, on the other hand, has no damaging effect on tea at dosages up to twenty gallons per acre and could serve both purposes, but the cost is too high for ordinary use.

There is thus reason to believe that if we create the proper circumstances for the growth of *Trichoderma*, it can play a useful part in the control of *Poria*.

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V. P. CLEARINGS AT ST COOMBS

A. L. Elias

This article has been asked for, to bring to light information about the V.P. clearings on St Coombs Estate, in the hope that certain lessons that have been learned will be useful to planters who are about to undertake similar work. These lessons were bitter ones at the time, but it is often true that we learn more from mistakes than from successes, and certainly the later St Coombs plantings have benefitted from the experience gained. The success of the 1959 plantings is particular evidence of this. It is felt that as our replanting programme proceeds, even greater success, based on ever-increasing experience, will be achieved.

No. 1. Field planting 1953–54 areas

Block 41.—The first planting by vegetative propagation (V.P.) in Field No. 1 was done during the north-east monsoon in October 1953, when Block 41 (A.0.–R.3 –P. 6.13) was planted with Clone TRI 2024. The old tea was uprooted and the ground smoothed, pegged and holed. There was no rehabilitation.

Initially, 2,931 plants were put out, but at a census taken in February 1956, 28 months later, only 1,656 plants showed vigorous growth; there were 1,275 vacancies. In April 1956, all large plants were tipped at 2 ft and vacancies re-supplied with basket plants. *Tephrosia vogelii* was planted in every alternate row. The ravine between Blocks 41 and 43 was stoned and stone-bunded as far as the grass area, as a soil conservation measure. This block has never yielded sufficiently well to justify a fraction of the money spent on it (Table 1.)

Block 60.—This block was planted with Clone TRI 2025 in June 1954 (A.1–R.0.–P. 29.75) after 2 years rehabilitation under Guatemala grass. Of 4,155 plants put out after trenching, 3,800 survived, leaving only 355 vacancies to be re-supplied.

TABLE 1.—*Plantings in No. 1 Field from* 1953–1957

Block No.	Clone No.	No. of bushes	AREA A.	R.	P.	Date of Planting	Yields, in pounds of made tea per acre 1956	1957	1958	1959	
41	2024	3,266	0	3	6.13	Oct. 53	71 (5 mths)	420	691	636 (5 mths)	Pruned.
60	2025	4,299	1	0	29.75	June 54	262 (8 mths)	1036	1352	610 (5 mths)	Pruned.
26	777	2,017	–	2	5.25	June 55	—	—	51 (2 mths)	399	
28	2025	1,062	–	1	1.87	,,	—	19 (2 mths)	274	1044	
44	2024	3,274	1	0	18.63	,,	—	22 (6 mths)	79 (8 mths)	227 (8 mths)	
46	2024	3,514	–	3	37.12	,,	—	28 (6 mths)	97 (8 mths)	156 (8 mths)	
59	2025	209	–	–	8.50	,,	—	—	—	—	
30	2025	50	–	–	6.56	July 55	—	—	—	160 (4 mths)	
43	2022	2,283	–	2	15.50	,,	5 (2 mths)	145 (6 mths)	346 (8 mths)	530 (8 mths)	
48	2024	130	–	–	7.87	June 56	—	—	—	240 (7 mths)	
49	2016	4,576	1	1	17.12	,,	—	—	—	241 (7 mths)	
55	2022	2,217	–	2	1.56	,,	—	—	—	376 (6 mths)	
56	2022	2,297	–	2	27.62	,,	—	—	—	383 (6 mths)	
25	777	3,150	–	2	37.81	June 57	—	—	—	—	
			8	3	21.29						

This block can be considered the only one where any degree of success with the original planting in No. 1 Field was achieved. In May 1956, all plants were tipped at 2 ft. *Tephrosia vogelii* was planted in every alternate row. All green manure and shade trees were manured. *Crotalaria* and pigeon pea were interplanted in every alternate row.

Later Plantings

Table 1 records the details, including yields, of Blocks 41 and 60 and twelve other blocks planted later, between June 1955 and June 1957. These data will be discussed later in comparison with plantings in Field No. 10.

No. 10 Field Planting 1952–54 Areas

To begin with, two areas were planted in Field No. 10, namely, a 2-acre block in 1952 and a 2½-acre block in 1954. The clones planted are given in Tables 2 and 3. Yield figures are given up to March 1960 in the case of the 1952 planting and up to April 1959 in the case of the 1954 planting, which was pruned from 27th to 29th April 1959, and thereafter reserved for clonal cuttings. These figures do not represent a true picture of relative yields because some rows of bushes of all the clones were allowed to grow up for providing cuttings. Clones were also used for the testing of fungicides and acaricides at various times.

TABLE 2.—*Yields, in pounds of made tea per acre from plantings in Field No.* 10 (2 *acres*) *in May* 1952

(The 1952 area was pruned between the 18th and 25th June 1957)

Clone No.	No. of bushes	July '54 to June '55	July '55 to June '56	July '56 to June '57	Dec. '57 only	Jan. to Dec. '58	Jan. to Dec. '59	Jan. to Mar. '60
2024	1,350	—	108 (a)	874 (b)	78	1970	1828	504
18	497	245	453	741	17	791	769	365
216	746	589	521	894	20	1270	1576	555
777	1,230	650	617	678	8	1089	1133	369
23	1,013	656	573	795	23	1341	1367	495
740	345	577	754	953	134	1818	1629	618
1526	240	1145	753	1238	15	1868	1367	306
1114	1,025	823	603	713	49	1744	1531	505
25	403	805	620	922	60	1883	1639	485
2024	1,136	1114	727 (c)	465 (d)	73	1118	983	348
777	1,080 (e)	—	—	316	12	950	1093	392
	9,065 bushes=4,532 per acre							

(a) 2 months only (b) 9 months only (c) 9 months only (d) 7 months only, (e) planted April 1953.

TABLE 3.—*Yields, in pounds of made tea per acre from plantings in Field No.* 10 (2½ *acres*) *in June* 1954

(The 1954 area was pruned between 27th and 29th April 1959)

Clone No.	No. of bushes	June to Dec. 1956	January to Dec. 1957	January to Dec. 1958	January to April 1959
2024	3,454	190	719	1310	222
2025	2,117	171	642	1605	354
2016	1,477	137	499	930	221
2022	1,515	132	673	1191	187
2021	1,358	159	586	1050	197
25	732	48	336	790	178
	10,653 = 4,261 bushes per acre				

Discussion

Many of the plantings in Field No. 1 were complete failures and the condition of the plants at the end of 1956 gave cause for grave concern. Much time and money had been spent, but the results did not show the many visitors who came to St Coombs that replanting was either desirable, or a sound economic proposition. The plantings in Field No. 10, on the other hand amply demonstrated the vast possibilities of new planting. They were a complete success. The point at issue is therefore, why did the No. 1 clearings fail? There are many factors which in my opinion have to be considered. I make the following comparisons:—

1. SOIL.—Field No. 10 has a rich soil, with a fine structure, capable of holding considerable moisture, even during severe drought conditions. In Field No. 1, even after 3 years under Guatemala grass (*e.g.* Blocks 8A & 8B) the soil appears to be dry, powdery and very friable, and incapable of retaining moisture. Thus heavy rainfall is absorbed by the soil, but appears to drain away very rapidly and a few days of intense sunshine causes rapid drying to take place.

2. TERRAIN.—Field No. 10 slopes gently, with an aspect facing the morning sun and with no rock in the vicinity. Field No. 1 generally faces away from the morning sun with the exception of Block 60—Clone TRI 2025—where casualties were small. The whole area is steep, with much rock.

These are two of the major physical differences between the two areas, but I do not consider that they were the only reasons for the failure of these clearings. Apparently the policy adopted for replanting the two areas was precisely the same except that plants in Field No. 10 (1952 planting) were planted out by means of a Hersall transplanter. All other plants were forked out of the nursery (not basketed) and a small amount of soil was balled around the roots. These were then planted into holes cut within the site of the trench which had previously been filled with rotted Guatemala grass loppings. In Field No. 10 the plants survived and thrived. In Field No. 1 many did not survive and few thrived. Two reasons can be given for this failure.

1. From weather records, it is evident that immediately after planting took place in Field No. 1, 1955-56 planting, there was a 3-week period of dry weather. This was not so in the case of Field No. 10—1952 and 1954 planting.

2. The Guatemala loppings were not sufficiently rotted at the time of planting, thereby creating minor subsidences through sinkage from time to time, and as further rotting took place after planting, this would naturally damage the stems, create a cavity below the roots, retard growth and finally kill some of the plants.

Evidence that there was a lack of organization and of proper care and attention, in the early stages of preparation for planting, is also available. The contour lining does not appear to have been done very carefully and, on filling the trenches, considerable adjustment of the original lining was necessary. This in turn meant that some plants were not planted in the original trench.

These plantings were delayed for some reason (planted in each year in June and July, instead of in April and May). There does not appear to have been a definite programme for plants and re-supplying a particular area each year. It would therefore seem that a combination of factors caused the failure of these original plantings. Some of these factors were man-made, and it is evident that the area planted in 1957, Block 25 (Clone TRI 777), and the 1959 plantings have benefitted from the mistakes that were made previously.

In order to rectify the situation as it then was, it was decided that all blocks should be re-supplied with available plants. Where plants of the appropriate clone were in short supply, all the existing plants were to be removed and the whole block replanted with available material. Thus, in the case of Block 56, originally planted with Clone TRI 25, all the plants were uprooted and Clone TRI 2022

planted instead. Similarly in Blocks 48, 55 and 59 planted with Clone TRI 1114, all plants were uprooted and these blocks replaced as follows:

Block	48	with TRI	2024	Basket plants
"	55	" "	2022	were used in
"	59	" "	2025	all cases.

The remaining blocks were all re-supplied in May/June, 1957, with basket plants of the same clone, after all original plants that were not up to standard had been removed and destroyed. The original plants and the subsequent supplies, despite the difference in age, do not now show any great difference in size. Records of the early stages of preparation for the 1955–56 plantings show that all blocks were trenched. Following re-supplying, all blocks were thatched with Guatemala grass from areas outside Field No. 1. All re-supplies were manured twice a year with T/175 mixture at 1 oz. per plant per application.

The system of forking out plants, balling the roots with earth and supplying in this manner was considered unsatisfactory, and it was decided that all plants should in future be basket plants. All these clearings now look extremely well and show great promise. Planting distances were $4' \times 2'$, $4\frac{1}{2}' \times 2'$, $5' \times 2'$.

Summary

The No. 1 clearings have proved to be a costly experiment, but it has proved an important point, namely, that it is unwise to replant any large area without first making a thorough examination of the land and laying down a definite programme. The mistakes made were as follows.

1. A thorough examination of the soil properties was not carried out prior to replanting. Soil tests for pH and for eelworm infestation should have been taken. It has recently been found that No. 1 clearings show a high degree of infestation with Meadow Eelworm, which, had it been known, would have indicated longer rehabilitation. It is important that soil conditions, weather conditions and aspect be given due consideration and the planting methods employed will therefore be dependent upon these factors.

2. Nursery organization must be of a very high order. In the case of the No. 1 plantings, this was not so. Small plants were put out on every occasion, adding insult to injury by balling the roots with earth. The chances of survival in the field were therefore slight even had the weather conditions after planting been perfect. It is most important that plants should be healthy and vigorous and at least one foot tall at the time of planting. Roots should be carefully preserved in transit and spread out evenly in the hole at the time of planting.

3. Trenching and filling the trenches with Guatemala grass loppings is a dangerous operation if the loppings do not break down and become part of the soil structure before planting operations commence. This caused trouble in all the plantings in Field No. 1. Holing is by far the best method and holes 18" deep by 8" have given satisfactory results.

4. Large gangs of labourers were employed in Field No. 1 immediately following planting. This should be avoided. The after-care of any new clearing should be the responsibility of a small trustworthy gang of labourers whose job throughout each month should be weeding, lopping green manure, thatching, tending plants, re-supplying when necessary, cleaning out drains, manuring and re-supplying shade. Damage to the young plants is reduced to a minimum if this method is strictly adhered to.

5. Field No. 1 is badly windswept during the south-west monsoon. However, no effort was made to establish some form of wind belt when these clearings were planted.
   Wind belts of some type of rapidly growing feathery shade (*Sesbania*) should be established as quickly as possible.

6. In all these clearings green manures of the bush type were interplanted. This should be avoided, owing to the intense competition with the young tea plants in the initial stages of their growth. *Tephrosia vogelii* in particular is also a known host plant for Meadow Nematode.

7. There is evidence that, in Field No. 1, thatching was delayed. If thatching is to be done, as much thatching material as possible should be laid down immediately following planting to assist with moisture retention in the soil in case the weather suddenly turns dry.

In conclusion it must be said that the replanting of tea with vegetatively propagated material is still being improved. All work connected with replanting therefore deserves careful planning throughout the whole period from the initial uprooting, and the closest supervision until the tea is finally brought into bearing.

NEMATODE SAMPLES FROM ESTATES

M. T. Hutchinson

Although the Institute will continue to request samples from estates for experimental purposes, routine samples for nematode analysis will no longer be accepted. Such samples should instead be forwarded to the Colombo companies mentioned in the following article.

The Meadow Nematode or Eelworm (*Pratylenchus coffeae*) was discovered as a pest of tea by Dr Gadd in 1939. Since that time more than 6,000 soil samples from estates have been examined at the Tea Research Institute for this nematode; with the result that we know it to be rather widely destributed at elevations above 4,000 feet. Only rarely does it present a problem at elevations from 3500-4000 ft. Below 3500 ft, this nematode occurs, but in numbers too small to cause appreciable injury.

The question now arises: "Is the further processing of *routine* estate soil samples by the Institute likely to be as useful to the tea industry as research directed at control of this pest?" This question arises at this time because of the increased research programme and the need to process more research samples. Judging from the ratio of estate samples over the past nineteen years, one-third more research could be done if the Institute did not process routine estate samples.

Faced with a choice between taking on another T.R.I. staff member with the proceeds of fees, or referring all routine samples to companies in Colombo, the Board of Control of the T.R.I. at its meeting of 4th June chose the latter course.

The Colombo Commercial Company Ltd. (P.O. Box No. 33), Messrs A. Baur & Co. Ltd. (P.O. Box No. 11), and Messrs Harrisons & Crosfield, Ltd. (P.O. Box No. 69) (as agents for Messrs Fisons (Ceylon) Ltd.), have been examining tea soils for nematodes since 1957. These companies are properly staffed and equipped for this work, and a five-day refresher course in plant nematology was recently held at the Institute for their representatives. Upon request, they have generously agreed to accept all estate samples now being sent to the Institute. However, since these companies carry out a large number of analyses in addition to those for nematodes, it is appropriate to consider how this extra work can be prevented from becoming a burden to them.

Judging from our own experience, many of the samples sent to the Institute are not strictly necessary, and many of those that could be useful are not taken so as to yield the most information per sample. The following questions should therefore be carefully considered.

Who should be concerned about nematode sampling?

It is evident that planters are aware of the general distribution of the Meadow Nematode, since we very rarely receive samples from low-country estates. Therefore, it is sufficient to say that no estate of less than 3,000 feet elevation should be concerned with sampling. Of estates between 3,000 and 4,000 feet elevation, there are very few where the Meadow Nematode is numerous enough to cause injury to tea. Even on estates 4,000 feet and above, half of those sampled have shown no Meadow Nematode. In the Dimbula and Dickoya Districts, 74 estates sampled are not known to be infested. Of the 75 infested estates, 17 are very lightly infested,

20 are moderately infested, and only 38 are heavily infested. It is evident, therefore, that not all poor growth on up-country estates can be attributed to the Meadow Nematode and that other factors such as lack of manure, too high pH, underlying slab rock, *Poria* root disease, Phloem Necrosis, mite injury, and even Shot-hole Borer just above 4,000 ft., can cause poor areas in up-country tea fields. Before sending a soil sample for nematode analysis, therefore, some attempt should be made to see if the above factors are causing trouble.

What parts of an estate should be sampled?

Poor areas in mature tea are the most important to sample. The Director's Editorial in the March 1960 issue of the *Tea Quarterly* requested estates to submit not more than three samples at any one time for analysis, since it was considered unlikely that an estate would suddenly discover more than three patches of poor tea that had not been noticed previously.

Nurseries and soil for basketing should be fumigated routinely before planting (see following note) and, therefore, need not be sampled for nematodes, unless nematode injury is suspected despite fumigation.

Areas in tea to be replanted are reconditioned with Guatemala grass as a matter of course, so that the extent of infestation before reconditioning is not important.

Young tea on reconditioned soil is not likely to show nematode injury unless the basket plants were already infested at the time of planting or if the area was weedy during reconditioning. If basket plants are obtained *only* from a nursery on the estate that is routinely fumigated, and if weeds (many of which can harbour Meadow Nematodes) are not permitted to grow in areas under Guatemala grass, there is no need to sample young plantings. Any nematodes washed down from higher areas of the estate into young plantings are not likely to become a problem until the tea is mature.

Areas in patana or jungle, to be opened up for planting, can justifiably be sampled, since they have been found to harbour small to moderate numbers of Meadow Nematodes.

How should a sample be taken?

Advice on this subject has been well presented by Tolhurst (1955) and the following is given as a brief review. Sampling should be done when the soil is moist but not wet. A handful of roots and soil is taken from around each of 10 plants, chosen at random throughout the affected area—including the edge of the area. Samples should be taken at a distance of 1–2 feet from the crown of the tea bush, at a depth of from 2–6 inches. The 10 samples are then thoroughly mixed together in a pan, and from this mixture is taken enough soil and roots to fill a cigarette tin or equivalent container.

Only one sample need be taken, regardless of the size of the area involved. This will tell whether or not Meadow Nematode is present. If it is present, resampling of smaller areas can be made, to determine whether or not it is present in sufficient numbers to cause marked injury (usually when 25 or more nematodes are recovered from 100 g. sample). The size of these smaller areas will depend on the size of the initial area, and the following table may be used as a guide:—

2	acres	...	1 sample
4	,,	...	2 samples
9	,,	...	3 ,,
16	,,	...	4 ,,
25	,,	...	5 ,,
36	,,	...	6 ,,
49	,,	...	7 ,,

The name of the estate, the field or section from which the sample was taken and any other pertinent information should appear on a label pasted to the container, since labels inside the container may become moist or soiled.

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Note:

Since this article was written, it has been brought to the attention of the writer that the larger roots of tea can survive for several years after the plants have been uprooted and can send up new shoots in areas being reconditioned with Guatemala grass. If present, these shoots and the underlying roots should be removed when weeding. Meadow Nematodes can possibly also be harboured in roots that are still alive but have not yet sent up shoots. Therefore, the number of Meadow Nematodes present before reconditioning commences may be important in determining whether reconditioning should be carried out for one or two years. Areas of mature tea to be replanted should therefore be sampled if the presence of Meadow Nematode is suspected. The possibility of survival of Meadow Nematode on buried roots suggests that when infested areas are being uprooted the removal of large roots should be especially thorough. This can best be done with a tractor-operated winch.

FUMIGATING NURSERIES

M. T. Hutchinson

All tea and green-manure nurseries of estates above 3,500 feet elevation should be routinely fumigated before planting, as a protection against Meadow Nematode. Nurseries below this elevation can probably benefit from fumigation.

Although such insects as cockchafer grubs can injure tea plants in the nursery, soil fumigation is primarily directed against nematodes. Of these, the Meadow Nematode, *Pratylenchus coffeae*, is the most important. In up-country, and in a very few high mid-country areas, a tea nursery infested with this pest can serve as a distribution centre to contaminate an entire estate. Green manure plants are never as heavily infested as tea, but shade trees such as *Albizzia moluccana* and *Acacia decurrens* can support small numbers of this nematode (Visser, 1959) and it would therefore be wise to fumigate nurseries that are to contain such plants.

Soil tests are not always reliable in determining whether or not Meadow Nematodes are present in nursery soil. Since the efficiency of the method used to extract nematodes from soil is not greater than 30%, Meadow Nematodes can be present that are not detected. During the time that plants are in the nursery, numbers that were originally very small may increase to considerable proportions. Therefore, proposed and existing nursery sites of up-country and high mid-country estates should be fumigated **each time** before they are planted, and soil for basketing should be fumigated regardless of its origin.

The root-knot nematode, *Meloidogyne javanica*, commonly found producing galls on the roots of *Tephrosia vogelii* and Dadaps (*Erythrina lithosperma*) thrives at all elevations, and can occasionally be a problem in tea and green-manure nurseries. With tea, the damage is limited to the time when the plants are in the nursery, since this nematode apparently will not survive on plants older than one year. With shade trees such as *Albizzia sumatrana*, the infestation may continue in the field (Visser 1959). Spiral, pin, and other plant parasitic nematodes found around the roots of tea at all elevations have not yet been shown to be harmful, but it would be well to assume that they might do harm to young plants.

Therefore, if plants in nurseries below 3500 feet are doing poorly, and if such factors as too high a soil pH, poor soil texture or drainage, or improper shading are not involved, it would be a good idea to fumigate a part of the nursery before the next planting, to see if growth is improved.

A simpler method of fumigation

The method previously recommended for fumigation nurseries required an injector gun. A simpler method of applying fumigant uses only a jar with two holes in the cap. The holes should be about one-eighth of an inch and placed at opposite sides of the cap, one to allow escape of the fumigant and the other to admit air.

Before fumigation, the entire nursery, including paths, is carefully cultivated and all weeds, old tea plants, etc. are removed. If a large amount of root debris is present, two weeks should be allowed so that the roots will have rotted and the nematodes will move into the soil. Trenches 6–8 inches deep and one foot apart are then made across the nursery. The fumigant is dribbled into the trench by a man walking at normal speed, and the trench is immediately covered with soil and firmed down by a second man. With Shell D-D mixture, approximately one pint

is used for 200 feet of row, giving a dosage of 25 gallons per acre. A trial (calibration) run can be made with a pint of water. After fumigation, the area is well-thatched and left for 3 days. After this time it can be thoroughly cultivated to allow escape of the fumigant from the soil. If the weather is warm and sunny, planting can be done after three weeks. Under cool and rainy conditions, an additional period of two weeks is recommended. Nematox can be used in a similar manner after being diluted with four parts kerosene. Nemagon is principally suited for sandy soils of low moisture content which are subjected to high temperatures—conditions not prevailing on up-country estates. However, it might be found suitable for use on low-country estates.

Fumigation should not be carried out when the soil is obviously wet, but when it is in a condition which would be suitable for planting.

Basket soil can be fumigated in the same manner if it is spread in a layer one foot deep over ground that has previously been fumigated.

Other considerations in the fumigation of nurseries have been noted by Visser (1959a).

Guarding against re-infection

Once they are fumigated, nurseries should be kept free of plant parasitic nematodes. This can be done by digging drains around them, to prevent nematodes washing in from tea or shade trees on higher ground. Soil from these drains should not be thrown on to the nursery, but should be put back on the slope from which it eroded. Care should be taken to prevent introduction of soil on the tools or feet of labourers.

Despite all precautions, however, nematodes will probably be reintroduced if, mature tea and shade trees on the estate are infested, and fumigation before each planting of the nursery is therefore necessary.

This emphasises the basic philosophy in nematode control, the object of which is not to eliminate nematodes—a virtually impossible task—but to reduce their numbers to a level at which they cannot do harm.

References

VISSER, T. (1959a). Practical aspects of the eelworm problem in tea. *Tea Quart.* **30:** 143–149.

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LETTERS TO THE EDITOR

Green Manure and Shade Trees

It seems to me that we have little accurate knowledge of the true function of shade trees in tea culture in Ceylon. We have been told that "tea itself was originally a jungle plant and its actual home appears to be in the jungles of North India and Burma where it apparently grew beneath a canopy of *Albizzia* type forest" (Portsmouth, 1951). Further, I note from another article by Portsmouth (1954) that the conclusions of the various shade experiments carried out at Tocklai some time ago show that yields have a general tendency to increase with decreasing light intensities. One table in this article shows that the taller the shade tree, the higher the yield. He concludes that "the question whether the benefits of natural shade are due merely to a reduction in light intensity, or to extra nitrogen produced by fixation, or to a combination of both effects, would appear to be still unsolved."

Again, Walter (1950) states, with reference to the work at Tocklai, that yields from areas under a normal shade density are in fact higher than from unshaded areas at all manurial levels up to 100 lb. of nitrogen per acre. A table in this article shows that the response to shade varies between a maximum of 19.1% increase in yield for areas with no nitrogen added and 2.5% increase in yield for areas with 60/90 lb. of nitrogen added per acre.

These results have been obtained at Tocklai and it would seem to me that similar experiments under Ceylon conditions might be very instructive. Apart from the effect of shade on yield, what is the effect on quality and flavour?

However, the choice of suitable trees for planting on estates in Ceylon is too limited, both by way of variety and because of specific susceptibilities to disease and to adverse climatic conditions. Efforts should perhaps be made to procure new species to be used either for the purpose of protecting and shading the tea or as a source of green manure. I will mention some of the failings of certain common available species.

The *Grevillea* harbours mites, and there appears to be no effective control, unless it be by lopping the lower branches. Pollarding might be done, but the *Grevilleas* are not then really high shade trees, and also the timber is less useful. This is a non-nitrogenous tree, although the deep root-system may be useful in bringing up plant food from the sub-soil. On exposed areas it will seldom do well and remains a knarled and blackened pole. In the seedling stage, *G. robusta* is susceptible to Root-knot Eelworm.

Albizzia sumatrana is slightly susceptible to Meadow Eelworm but very susceptible to Root-knot Eelworm. This tree can give a high feathery shade, but if established as such, the value for green manure is small. Perhaps because the trees grow very fast, sudden changes in temperature and weather can cause wilt, and then little foliage remains. Some planters favour lopping this species to form a medium-high shade tree, but many have an aversion to using it and there is a particular need for an alternative high shade tree. Perhaps a deciduous species that would provide mulch, without the costs of lopping, and shade at the right time would be the answer.

Albizzia moluccana is susceptible to a fungus which yellows the leaves and can cause complete defoliation. This species also harbours mites, even after pollarding. It is easily damaged by winds if left unlopped.

Acacia decurrens is slightly susceptible to Meadow Eelworm. It has a prolific lateral root system and some planters have discarded it on this account, especially on new clearings. Casualties are fairly numerous, attributed in some cases to severe lopping during dry weather. The bark cracks easily, forming scars which do not always heal.

Dadaps are susceptible to eelworms, although once well established they seem to be one of the best sources of mulch.

It is sometimes contended that trees protect the soil and tea from driving rain and wind as well as providing shade. In practice, the management of these "shade" trees is not done on a scientific basis. With regard to shade, it is customary to leave trees unlopped before the dry weather but the number of suitable trees per acre should be sufficient to provide optimum cover. Water-loss by transpiration is proportional to the leaf surface area, and it is contended in some quarters that, during drought periods, shade should be controlled by lopping. Furthermore, the loppings may be considered more useful as a protective thatch on the ground than as a limited source of shade left on the tree. Opinion on this point seems divided.

On another point, more attention might be given to producing young shade tree plants in the nursery at such a time that, planted out into well-prepared holes, they are of a sufficient height to grow above the tea from the start. Uprooting and replanting should be done systematically according to the growth of the various species.

With regard to protection from rain, part of this is usually removed by the usual pre-monsoon lopping and, in the case of Dadap and *Albizzia*, little protection is provided. Heavy rain usually fells *Grevillea* leaves, and the steady drip can cause damage to anything underneath, be it tea or a road surface. With the advent of sun recorders as an aid to blister-blight spraying, the practice of the wet weather lop might be reviewed.

With regard to protection from wind there are few trees, apart from *Acacia*, in use on estates which will stand up to really strong winds. It is customary, therefore, to lop before the winds commence, in order to prevent damage to the tree, but the protection to the tea is thereby diminished.

Shade trees provide green manure in the form of loppings and natural leaf-fall; however, in practice, lopping is often more of a firewood collecting exercise, and if the green loppings are left in a heap below the tree, they can be beneficial to a small area only. If the cover of tea is good the even spread of loppings is difficult.

In conclusion, I feel that this is an important subject and additions to, or enlargement of, what I have written would be most welcome. I have tried to produce contradiction to what is considered established practice, in the hopes that this will stimulate discussion.

R. K. Christie

Lindoola,
Talawakele.
13th May, 1960.

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SUMMARY MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD IN THE GENERAL COMMITTEE ROOM OF THE PLANTERS' ASSOCIATION OF CEYLON, 73/1, KOLLUPITIYA ROAD, COLOMBO, AT 9 a.m. ON FRIDAY, 3rd JUNE, 1960

Present.—Messrs F. Amarasuriya (Chairman), G. I. de Glanville (Chairman, Agency Section, Planters' Association of Ceylon), H. E. Peries, O.B.E., C.C.S. (Deputy Secretary to the Treasury), B. Mahadeva, C.C.S., (Tea Controller), R. M. Macintyre, R. J. Gilmour, R. D. Wedd, J. L. D. Peiris, E. Jayawickreme, D. E. Hettiarachchi, N. M. Sanders, Dr D. L. Gunn, C.B.E. (Director, T.R.I.), Messrs G. A. D. Kehl (Administrative Secretary), and H. J. Balmond (Secretary).

Dr A. W. R. Joachim, O.B.E., Low-country Adviser, was present by invitation during the discussion on low-country business.

Messrs E. Muttukumaru, C. R. Webber and R. C. Scott, C.B.E., regretted their inability to attend.

1. **Minutes of the Metting of the Board held on 4th March, 1960**

The minutes of the meeting of 4th March, 1960, were confirmed.

2. **Matter arising out of the minutes**

The Board received short reports on certain matters not dealt with later during the meeting.

Certain matters regarding insurance were discussed and the Board decided that the Administrative Committee should review existing insurance policies when it considers the allocation of insurance for next year.

3. **Membership of the Board and Committees**

(a) **The Board.**—The Board received the following reports:—

(1) Mr E. Muttukumaru, J.P., on election as Chairman of the Low-country Products Association, becomes an *ex-officio* member of the Board as from 28-3-60 in place of Mr C. Selwyn Samaraweera, the outgoing Chairman of the L.C.P.A.

(2) Mr W. H. W. Coultas will be on leave and out of the Island from 13-5-60 to 15-10-60 and the Planters' Association has nominated Mr C. R. Webber of Fordyce Group, Dickoya, to act for Mr Coultas during his period of leave.

(b) **Administrative Committee.**—The Board nominated:—

(1) Mr N. M. Sanders to act for Mr Coultas during his absence on leave.

(2) Mr E. Muttukumaru to take the place of Mr C. Selwyn Samaraweera.

(c) **Experimental & Estate Committee.**—The Board nominated Mr N. M. Sanders to take the place of Mr Coultas during his absence on leave.

(d) **Building Committee.**—Reported that Mr N. M. Sanders had agreed to act as Chairman of the Building Committee during the absence of Mr Coultas.

4. **(a) Minutes of the Administrative Committee held on 22-4-60 and Financial Appendix**

The minutes of the Administrative Committee meeting held on 22-4-60 were tabled for discussion and adoption.

(1) **Electricity Supply: Mr Thorne's Report.**—The Chairman said the Administrative Committee had recommended the acceptance of Scheme I.

Mr de Glanville asked whether the automatic mains-failure set was likely to be used.

The Director said that a continuous supply of electricity to the laboratory was essential, especially where constant temperatures were being used, as any failure of supply might ruin experiments. The cost of the mains-failure set was small when compared with the damage to experiments that might be caused by a breakdown in supply.

(2) **Development Division and Instant Tea.**—The Director said that he wished to defer the memorandum on the Development Division until the position regarding Instant Tea was clear, and until a Biochemist had been appointed.

(3) **Application of Shop and Office Employment Act.**—The Chairman stated that consequent upon the enforcement of the Shop and Office Employment Act with retrospective effect, arrears of overtime had to be paid to clerical and other office staff. In addition, the existing vote of Rs 5,000 to meet overtime expenditure was almost exhausted, Rs 4,750 having been spent so far, and further supplementary provision of Rs 5,000 was needed.

After some discussion Mr Errol Jayawickreme proposed, seconded by Mr Hettiarachchi, that the supplementary estimates of Rs 11,436.87 and Rs 5,000 be approved. The Board approved the expenditure.

(4) **Use of Board's Seal.**—The Director said that under the Rules made by the Board the approval of the whole Board was required before the Seal could be used and that had involved delays in the past. The proposal now was that the Board should amend the Rules in the way suggested in Paper B. 22/60, so as to make it easier to fix the Board's Seal without calling a special meeting of the Board for this purpose.

The matter was discussed. Mr Gilmour then proposed, seconded by Mr Mahadeva, that Rule 13 of the Board be amended as follows:—

In Rule 13 substitute the words "not normally" for "never", and add the following proviso:—

> "Provided that the Board may from time to time authorise that the Seal may be used in special cases without authority obtained previously but subject to report to the Board; and provided further that in such cases the Seal shall be affixed in the presence of the Chairman, the Director and one other member of the Board, and they shall sign the instrument to which the Seal is affixed."

The Board approved the amendment.

(5) **Institute's Accounts as at 30-4-60.**—The Balance Sheet, the Asset Account, the Research Revenue and Capital Expenditure accounts of the Institute and the Estate Working Account and Estate Revenue and Capital Expenditure Accounts as at 30-4-60, together with a summary of estimated expenditure to date on account of capital and revenue, which had been circulated, were tabled for discussion and adoption.

In reply to questions raised the Director said that all loans and advances were being made in accordance with the rules laid down by the Board, and all requests were carefully examined.

Research Revenue Expenditure.—Agreed that the heading "Administration" should be substituted for "Administration of the Board".

Summary of Estimated Expenditure.—Mr Gilmour thanked the Secretariat for the statement showing estimated expenditure to date; it was exactly what was wanted and would be extremely useful.

On the proposal of Mr de Glanville, seconded by Mr Sanders, the accounts of the Institute as at 30-4-60 (Paper B.25/60) were adopted.

The Board then approved the minutes of the Administrative Committee held on 22-4-60 and the financial appendix, subject to the corrections made by the Board.

4. (b) **Draft Minutes of the Special Administrative Committee Meeting held on 9th May 1960**

The Chairman reported that the minutes had been approved by the members of the Administrative Committee, subject to the following amendment:—

Page 2. In place of paragraph 4 "Mr Peiris was.....to a rupee", insert the following:—

> "Mr Peiris stated that on the average cost of production of tea, the proposed cess would be about .6% and was a negligible amount, when one considered the importance of research and the spread of scientific development. As such he was of opinion that the Low-Country Products Association would readily agree to the increase."

The minutes were tabled for discussion and adoption.

(1) **Increase in Cess.**—The Director said that in addition to the papers circulated with the minutes, the following papers relevant to the subject had also been circulated:—

(1) Letter from Planters' Association of Ceylon, dated 26-5-60 (Paper B.27/60).

(2) Letter from Ceylon Association in London, dated 26-5-60 sent through the Planters' Association (Paper B.28/60).

The Administrative Committee had recommended that the cess should be increased to Re 1/- and he had circulated a memorandum on the subject (Paper B.15/60) to the Board and to the other authorities concerned. The Agency Section asked for more information, which was impossible to give for a five-year period. The Advisory Committee of the Ceylon Association had agreed that the proposed increase in the cess to Re 1/- should be supported and their recommendation was being put up to their Council yesterday. The Low-Country Products Association had minuted their approval of the request for an increase in the cess and official confirmation was awaited. They had thus received the support of all the authorities concerned, subject to the qualification made by the Agency Section of the Planters' Association.

Mr de Glanville said that the Industry would support an increase in the cess, as everyone realised that funds must be made available to the Institute to carry out research, but the view of the Agency Section was that it was hoped that sufficient information would be available to them which would help them to present a case that would warrant the considerable expenditure being envisaged. It would be sufficient if the Director could prepare a statement of the programme of work contemplated indicating the main lines of development which would justify the request for an increase in cess.

After further discussion the Director agreed to prepare a statement for the Planters' Association indicating the main lines of future development envisaged, provided it was accepted that such a statement could not be regarded as rigid but was liable to change.

The Chairman then moved that an application be made to the Government recommending a further increase in the Tea Research Cess from 75 cents to Re 1/- per hundred pounds of tea exported.

The Board unanimously approved the motion.

(2) **Powder Tea.**—The following documents, which had been circulated, were tabled for discussion:—

B.17/60. Director's memorandum on Powder Tea.

B.27/60. Letter from Planters' Association of Ceylon dated 26-5-60.

B.28/60. Letter from Ceylon Association in London dated 26-5-60.

In the discussion which ensued the view was taken that the pilot manufacture of powder tea had produced results which offered good prospects for further development on a commercial scale and that investigations should be made into the possibilities of the commercial manufacture of the product. The matter was outside the functions of the Institute and beyond its financial capacity. Nor was it likely that any single estate or individual or group of estates or individuals within the Island would sponsor the project because of the high costs involved in developing the project and because the manufacture and the retailing of the product were so closely linked, that, without an efficient selling organization, there might be serious losses. It was therefore essential that the commercial manufacture of the product should be sponsored by a food processing and distributing organization from outside the Island, preferably from the United States, where a new market with a high sales potential existed for the type of product envisaged. It was accepted that the existing U.K. tea interests should first be considered in the scheme, but it was also noted that the sale of powder tea in the conventional tea market in the U.K. would be nothing more than a transfer and perhaps a damaging transfer, which might be avoided if the product was directed to the American market and sponsored by American capital investment in the development of the product.

It was felt that in view of the wide issues involved the project would require the support and perhaps the direction of the Government and that the Ministries concerned should be advised of the development. The matter was, however, extremely urgent and the immediate need was that an Economic Committee, with power to co-opt, should examine the matter in detail and report to the Board; at the same time the Director should continue the informal approaches to the U.S.O.M. commenced earlier with a view to exploring the possibility of American interest in the project.

After further discussion the Board accordingly decided on the proposal of Mr Gilmour, seconded by Mr de Glanville:—

(1) that an Economic Committee on Instant Tea be constituted, with power to co-opt, to examine the whole matter in as much detail as possible;

(2) that the Ministry of Commerce and Trade, and other connected Ministries, be advised of current developments and future lines of action; and

(3) that the informal negotiations be continued with the U.S.O.M. with a view to exploring the possibility of American capital investment in the development of the project.

The following were appointed to the Committee:—Messrs F. Amarasuriya (Chairman), also representing the interests of the Low-Country Products Association; R. J. Gilmour, representing the Agency Section, Planters' Association of

Ceylon; B. Mahadeva, Tea Controller; W. H. W. Coultas (Mr N. M. Sanders to act for Mr Coultas while he was on leave); H. E. Peries, Deputy Secretary to the Treasury; V. L. Wirasinghe, Director of Commerce; Dr D. L. Gunn, Director, T.R.I.; Secretary: Mr H. J. Balmond.

It was agreed that the Committee should co-opt members of the Tea Traders' Association and the Ceylon Tea Propaganda Board when consultations with these organizations seemed necessary.

(3) **Recommendations of the Provident Fund Committee.**—The recommendations of the Provident Fund Committee as recorded in the minutes were noted.

(4) **Dr Tubbs's visit.**—The Board agreed that the cocktail party for Dr Tubbs be held on 4th August, and that the invitations be restricted to members of the the Board.

The Minutes of the Special Administrative Committee meeting held on 9th May, 1960, were then approved subject to the amendments made by the Board.

5. Minutes of the Sub-Committee appointed by the Administrative Committee to consider Anomalies in salaries, etc.

Reported that the Committee's report had been circulated to the members of Board.

The following amendments were made:—

(1) **Change of date of increment.**—It was agreed that the prevailing practice should continue.

(2) **Sick leave—Minor Staff.**—Reported that Mr Macintyre had suggested that sick leave for minor staff should be accumulated up to a maximum of 3 months for three years. The Board agreed.

The Board then approved the Anomalies Report subject to the above amendments.

6. Minutes of the appointments Committee meeting held on 26-3-60

The minutes of the Appointments Committee meeting held on 26-3-60 were tabled for discussion and adoption.

(1) **Appointment of Biochemist.**—The Director said that, after interview, an offer had been made to an applicant who was extremely satisfactory as a scientist and with the right kind of experience, but the applicant had later withdrawn, partly for personal reasons of health, and partly because of the short duration of contract, which in his case was five years. Further action had since been taken through personal channels to explore the possibility of obtaining a suitable biochemist, but it seemed unlikely that a suitable person would accept a short-term contract.

(2) **Appointment of Plant Breeder.**—The Director reported that Mr Green's emoluments at Tocklai had been satisfactorily assessed.

The terms of contract of overseas-recruited staff were discussed and the Board decided that such an officer could be offered the alternatives of:—

either (*a*) on an agreement for a specified period of years as determined by the Board;

or (*b*) on an agreement which would remain in force until the officer appointed thereby has completed his fifty-fifth year with an option for the Board to renew the agreement so that it may continue in force beyond the officer's fifty-fifth year, subject to such conditions as the Board may determine.

In the latter case it shall be expressly reserved that the Board reserves the right to terminate the agreement at any time by giving six months' notice to the officer concerned.

(3) **Next Appointments Committee Meeting.**—Reported that a meeting of the Appointments Committee had been fixed for the 21st July, to interview candidates for the posts of Agronomist and Statistician. Dr Tubbs would attend this meeting. The Chairman suggested that Dr Joachim be co-opted to the Appointments Committee for this interview. The Board agreed.

Mr Wedd was nominated to act for Mr de Glanville on the Appointments Committee during his absence on leave.

7. Minutes of the Low-country Sub-station Committee Meeting held on 19th May 1960

Dr A. W. R. Joachim was present, by invitation, during the discussion of the Minutes.

The Director's memorandum on the purchase of Denawaka Estate (Paper B.24/60) and the Minutes were tabled for discussion and adoption.

After discussion the Board agreed:—

That Denawaka Estate should be purchased, on terms indicated, for the establishment of a Low-country Sub-station, subject to a satisfactory report on the title.

The minutes of the Low-country Committee of 19-5-60 were then approved subject to the amendments made by the Board.

Dr Joachim left the meeting.

8. Minutes of the Experimental and Estate Committee Meeting held on 7-5-60 and Financial Appendix

The Chairman called for discussion and adoption of the minutes. The Director brought to the notice of the Board the following items:—

(1) **Future replanting on Estate.**—The Experimental and Estate Committee recommended a very heavy replanting programme for experimental purposes. This would mean that for the first five years the profits would go down.

(2) **Labourers' Accommodation.**—The original estimate for additional accommodation for labourers on the estate had been included in the Annual Estimates but had been deferred for further examination and report by the Visiting Agent. The Experimental and Estate Committee considered the Visiting Agent's report and recommended the supplementary estimate of Rs 34,046.04.

(3) **Routine Eelworm Analysis.**—The Experimental and Estate Committee recommended either a charge of Rs 5/- per analysis or that planters be advised to refer their samples to The Colombo Commercial Co., Messrs Harrisons & Crosfield, Ltd. (as agents for Fisons (Ceylon) Ltd.), or Messrs A. Baur & Co., Ltd. Dr Hutchinson had just completed a refresher course for a technician of each of the three companies.

The Board agreed that planters be advised to send their samples to the firms concerned.

The Board then approved the supplementary estimates recommended by the Experimental and Estate Committee, and adopted the minutes.

9. Minutes of the Shot-hole-borer Committee meeting held on 14-5-60 & financial appendix

The Board approved the supplementary estimate of Rs. 16,970 to meet the cost of large-scale dieldrin spraying tests and adopted the minutes.

10. **Staff**

(1) **Mr J. V. Sabanayagam, Technical Assistant: Extension of Study Leave.**—Agreed that if the Colombo Plan Fellowship was not extended for a further year, the Institute should meet the expenses of Mr Sabanayagam's study leave.

(2) **Mr V. A. Rangalla—Library Clerk.**—Agreed that Mr Rangala be designated as Library Assistant and be paid an allowance as from 1-1-60 for additional duties undertaken by him, the allowance to cease as soon as a Librarian was appointed.

11. **Other Business**

(1) **Bank Account for Low-Country Adviser.**—On the proposal of Mr Mahadeva, seconded by Mr J. L. D. Peiris, the Board resolved that a bank account be opened at the Bank of Ceylon, Galle, for payments of wages, etc. on account of the V.P. station at Kottawa. Dr A. W. R. Joachim, Low-Country Adviser, was authorised to operate the account.

(2) **Annual Report.**—The Director reported that the scientific and estate parts of the report were ready. He was awaiting the Auditors' report. The Board report would be circulated to members before printing.

The Auditors had agreed to conduct an interim audit in future, in order to have the audited report out earlier than in previous years.

H. J. BALMOND
Secretary.

Printed for the TEA RESEARCH INSTITUTE OF CEYLON, *St Coombs, Talawakele,*
by H. W. CAVE & CO., LTD., *Fort, Colombo.*